L. L. NARAYANA and D. RAO*: Floral morphology of Linaceae

ナラヤナ&ラオ*: アマ科植物の花部形態

Only Saunders (1937) studied the floral anatomy of a few members of the Linaceae in the past. Recently Narayana (1964) investigated the floral anatomy of five species of the family. The present contribution describes the floral anatomy of the following genera and species of the Linaceae: *Roucheria griffithiana* Planch., *Hebepetalum humirifolium* (Planch.) Benth., *Ochthocosmus africanus* Hook. f. and *Ixonanthes icosandra* Jack.

Material and methods Fixed material of *Ochthocosmus africanus* was supplied by Dr. T. S. Bakshi (Africa), and *Roucheria griffithiana* and *Ixonanthes icosandra* by Dr. Anwari Dilmy (Indonesia). The Herbarium material of *Hebepetalum humirifolium* was obtained from the Director, Botanic Gardens, Rio de Janeiro (Brazil). Customary methods of dehydration, infiltration and embedding were followed. The method adopted for processing the herbarium material of *Hebepetalum* was the same as described for *Durandea* (Narayana, 1964). Sections cut at a thickness of 8–12 microns were stained with crystal violet, and erythrosin was used as counter stain.

Morphology of the flower The flower is pedicellate, pentacyclic, pentamerous, regular, bisexual and hypogynous except in *Ochthocosmus africanus*, where it is tetracyclic (Figs. 34, 35). In *Roucheria griffithiana* the pedicel is covered by whorls of bracts (Figs. 1, 3–6). The topmost one is adnate to the innermost sepal (Figs. 1, 8–10). The five imbricate sepals are synsepalous at the base in *Ochthocosmus africanus* and *Ixonanthes icosandra* (Figs. 32, 33, 46) and free in the rest (Figs. 9, 10, 20, 21, 23). The free petals are imbricate in *Ixonanthes icosandra* (Fig. 47) and contorted in the rest (Figs. 27, 34–36). In *Ixonanthes icosandra* there are 15 stamens of which 5 belong to the antesepalous whorl and 10 to the antepetalous whorl. In *Hebepetalum humirifolium* and *Roucheria griffithiana* there are 10 stamens of two heights, those belonging to the antepetalous whorl being shorter. Fig. 27 shows the shorter antepetalous stamens and the filaments of the longer antesepalous stamens. In *Ochthocosmus africanus* there are only 5 antesepalous stamens (Figs. 35, 36). The filaments of the free stamens in *Ochthocosmus africanus* and *Ixonanthes icosandra* are

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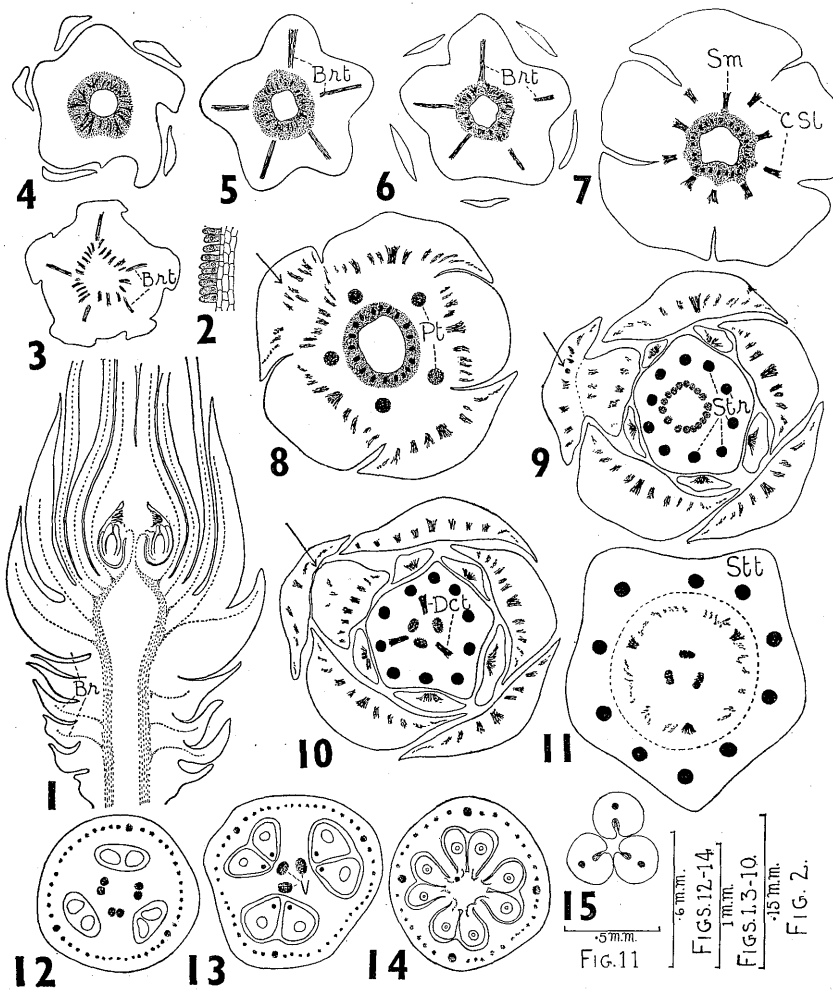


Figs. 1-15. *Roucheria griffithiana.* Fig. 1. L.S. flower showing the vascular supply to the different floral parts; upper part not shown. Fig. 2. Clavate hairs on the adaxial surface of the bracts. Figs. 3-15. Serial transverse sections of flower; for explanation see text. Arrow mark in Figs. 8-10 shows the bract which is adnate with the innermost sepal.

Br. Bract/Bracts; Brt. Bract trace; Sm. Sepal midrib trace; Sl. Sepal lateral trace; CSl. Common sepal lateral trace; Pt. Petal trace; St. Staminal tube; Str. Staminal trace; Stb. Staminal bundle; Dct. Dorsal carpellary trace; Dcb. Dorsal carpellary bundle; Ml. Common median lateral trace; ml. Median lateral bundles; CV. Common ventral bundles; V. Ventral bundles; D. Disc.

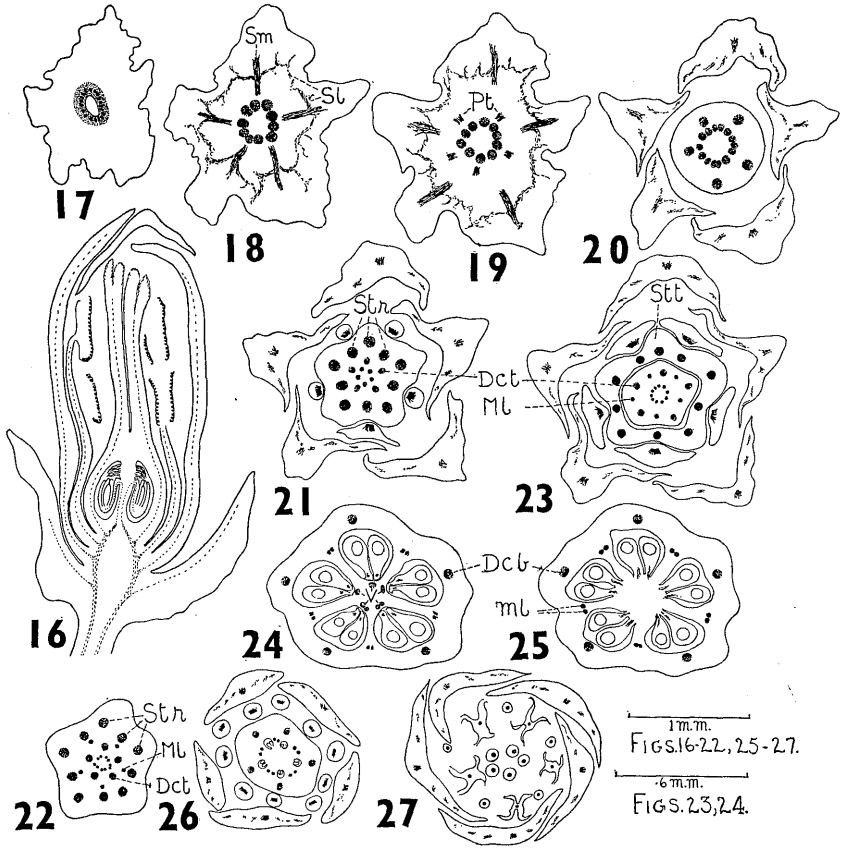
adnate to the disc for a short distance (Figs. 34, 35, 46, 47). In the other two species the stamens are united into a short tube at the base (Figs. 11, 23). The gynoecium is 3-4 carpellary in *Roucheria griffithiana* (Figs. 13, 14) and 5 carpellary in the remaining species with 2 pendulous ovules in each loculus (Figs. 24, 25, 34, 35, 46, 47). The styles are free in *Roucheria griffithiana* and *Hebepetalum humirifolium* (Figs. 15, 16, 27). The common style, hollow in *Ochthocosmus africanus* and solid in *Ixonanthes icosandra,* splits into five lobes at the apex (Figs. 28, 36, 37). The stigmatic lobes bear glandular hairs.

A prominent intrastaminal disc is present in *Ochthocosmus africanus* and *Ixonanthes icosandra* (Figs. 34, 35, 46, 47). It consists of a group of compactly arranged polygonal parenchymatous cells with thin walls enclosing dense cytoplasm and prominent nuclei. It is non-vascularized and has a secretory function.

Floral anatomy The pedicel shows a siphonostele (Figs. 17, 29, 39). In *Roucheria griffithiana* the pedicel is covered by whorls of bracts each of which receives a trace from the stele of the pedicel (Figs. 1, 3-6). A bract of the topmost whorl is adnate to the innermost sepal and separates from it at a higher level (Figs. 8-10). The adaxial epidermal layer of the bract consists of clavate, loosely arranged glandular cells (Fig. 2). In *Roucheria griffithiana* the common sepal lateral traces and sepal midrib traces depart in two closely alternating whorls (Fig. 7), while in *Hebepetalum humirifolium*, *Ochthocosmus africanus* and *Ixonanthes icosandra* the lateral traces of sepals arise conjointly with the sepal midrib traces (Figs. 18, 19, 30, 31, 40-43). The traces that supply the sepals in *Roucheria griffithiana* and *Ixonanthes icosandra* are divided forming smaller branches (Figs. 8-10, 46, 47), while in *Hebepetalum humirifolium* and *Ochthocosmus africanus* the lateral traces of adjacent sepals are united, forming loops from which branches are produced and these in turn enter the sepals (Figs. 18, 19, 31, 32). The bract adnate with the innermost sepal in *Roucheria griffithiana* is vascularized by the bundles of this sepal (Figs. 8-10). The cells of the adaxial epidermis of the sepals in *Ixonanthes icosandra* are palisade-like and enclose dense cytoplasm and prominent nuclei (Fig. 38).

The traces for the petals arise directly from the main stele (Figs. 8, 20, 31, 32, 40, 41).

The ten staminal traces in *Hebepetalum humirifolium* originate in two whorls, the antesepalous and antepetalous (Fig. 21). In *Roucheria griffithiana* and *Ixonanthes icosandra* they arise in one whorl (Figs. 9, 41). It is interesting



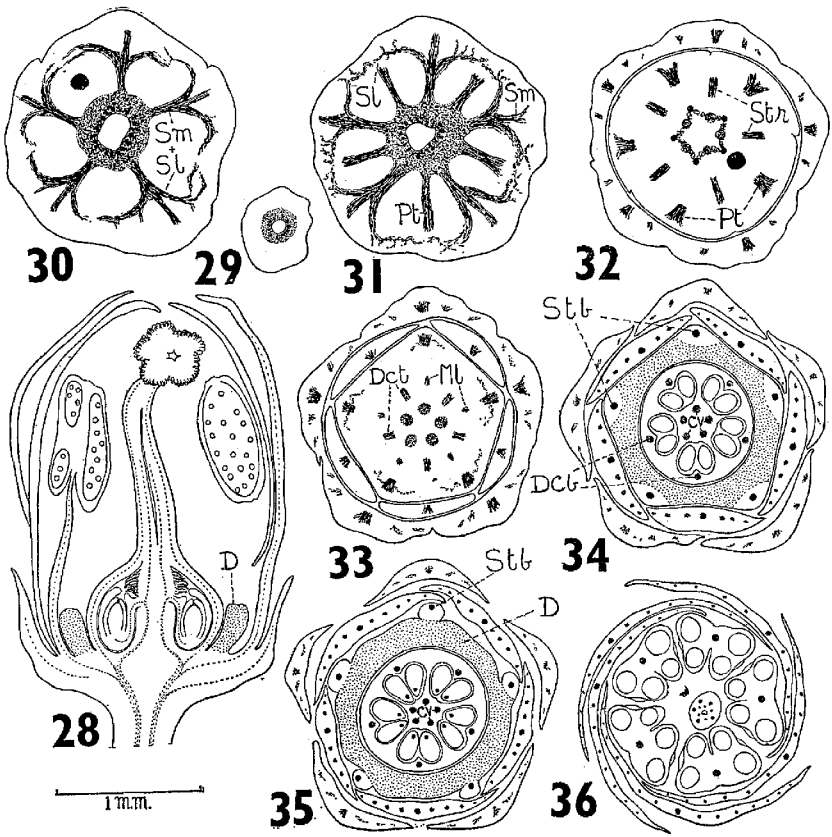
Figs. 16-27. *Hebepetalum humirifolium.* Fig. 16. L.S. flower-bud showing the traces for the different floral parts. Figs. 17-27. Serial transverse sections of flower-bud; for explanation see text.

to note that in the latter species, though there are 15 stamens, only ten staminal traces are organized. The antepetalous staminal traces undergo radial splitting and the two branches which supply the two stamens swing along the sides and lie close to the unsplit antesepalous traces (Figs. 41, 47). Thus the bundles for the stamens become arranged in five groups of three bundles each (Fig. 47). *Ochthocosmus africanus* has five antesepalous stamens and these are supplied by five traces (Fig. 32). There is however no evidence, either external or internal, for a suppressed antepetalous whorl of stamens. The staminal

traces, before they enter the filaments, give rise to slender lateral branches which end in the receptacle (Fig. 33). The smaller branches, produced by the staminal traces towards the centre in *Ixonanthes icosandra*, supply the ovary wall (Fig. 45).

Above the level of delimitation of the staminal traces five dorsal carpellary traces arise in *Hebepetalum humirifolium*, *Ochthocosmus africanus* and *Ixonanthes icosandra* and they remain unbranched throughout (Figs. 21–26, 33–35, 43–47). Depending upon the number of carpels in the gynoecium, 3–4 dorsal carpellary traces are organized in *Roucheria griffithiana* (Fig. 10). The branches of them supply the ovary wall (Figs. 11–14). The common median lateral bundles arise conjointly with the antepetalous staminal traces in *Hebepetalum humirifolium* (Fig. 22) and with the common ventral traces in *Ixonanthes icosandra* (Fig. 44). In *Ochthocosmus africanus* they are conjoint with the antesepalous staminal traces (Fig. 33). Although these terminate within the receptacle in *Ochthocosmus africanus* and *Ixonanthes icosandra*, in *Hebepetalum humirifolium* they are divided radially into two at the base of the septum, and extend to the top of the ovary (Figs. 24–26). The remaining portion of the stele after the origin of the dorsal carpellary traces organizes into as many common ventral bundles as there are carpels in *Ochthocosmus africanus* and *Ixonanthes icosandra* (Figs. 34–35, 44–47). *Roucheria griffithiana* and *Hebepetalum humirifolium* resemble one another in the behaviour of the bundles in the centre after the origin of the dorsal carpellary traces, three in the former species (or four when the number of carpels is four) and five in the latter (Figs. 11–13, 21). At a higher level the number of bundles becomes double (Figs. 12, 22, 23). These arrange themselves in close pairs forming the ventral bundles of each carpel (Figs. 13, 23, 24). Judging from the position of the ventral bundles the placentation in *Roucheria griffithiana* and *Hebepetalum humirifolium* may be regarded as axile and anatomically parietal in the other two taxa. The ventral bundles are completely utilized in the formation of the ovular supply (Figs. 14, 25, 47) except in *Ochthocosmus africanus* where, after supplying the ovules, they even enter the style for some distance (Fig. 36). The dorsal carpellary bundles traverse the styles or the common style (Figs. 15, 16, 27, 28, 36, 37) and finally terminate near the base of the stigmatic lobes.

Discussion The floral plan in Linaceae is basically pentacyclic and pentamerous. In *Radiola*, however, the flower is tetramerous (Saunders, 1937). A



Figs. 28-36. *Ochthocosmus africanus*. Fig. 28. L.S. flower showing the vascular supply to the different floral parts. Figs. 29-36. Serial transverse sections of flower-bud. for explanation see text.

tendency towards reduction in the number of stamens and carpels is seen in some groups like *Roucheria griffithiana*, *Ochthocosmus africanus* (the present study), *Linum grandiflorum*, *L. rubrum* and *Reinwardtia trigyna* (Narayana, 1964).

The 3-traced condition of the sepals and their quincuncial aestivation appear to be a uniform feature for the family. The connation of the sepals, observed in *Ochthocosmus africanus* and *Ixonanthes icosandra*, is absent in the rest of the investigated species. There is connation between the lateral traces of adjacent

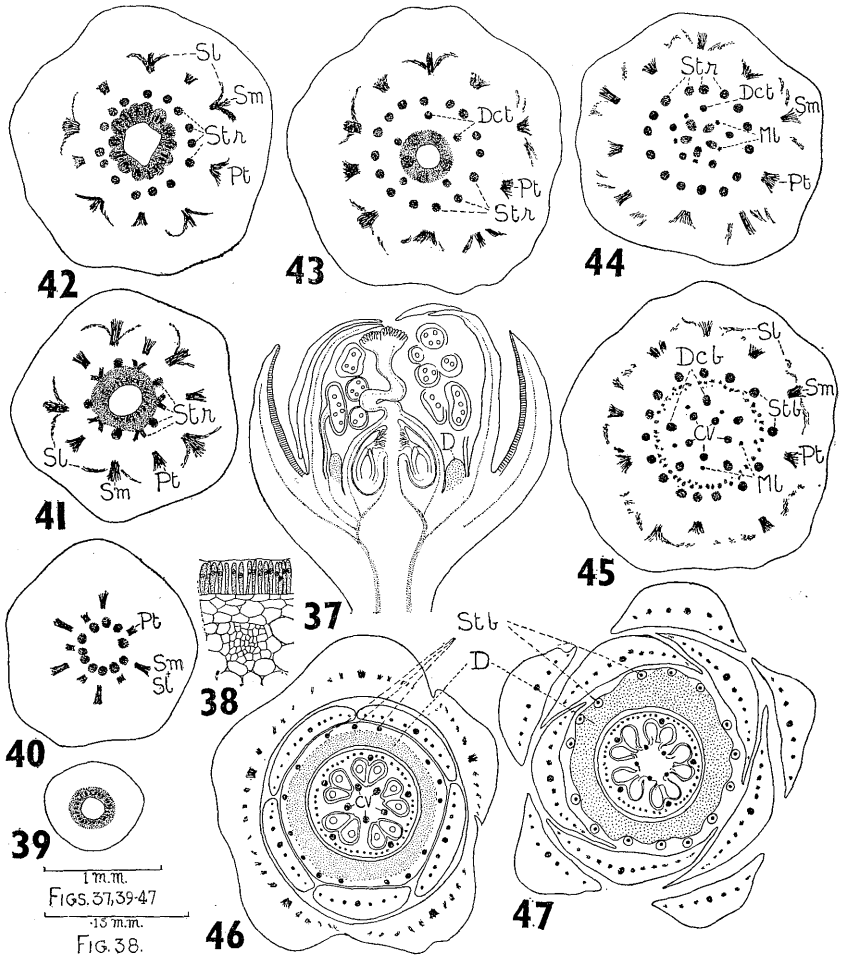
sepals in *Roucheria griffithiana* (present study), *Durandea pentagyna*, *Hugonia mystax* and *Linum grandiflorum* (Narayana, 1964), or the lateral and midrib traces of the same sepal may arise conjointly as in *Hebepetalum humirifolium*, *Ochthocosmus africanus*, *Ixonanthes icosandra* (present study), *Reinwardtia trigyna* and *Linum rubrum* (Narayana, 1964). Formation of loops by the fusion of the lateral traces of adjacent sepals as reported for *Hopea racophloea* (Rao, 1962), a member of Dipterocarpaceae, has been seen in *Hebepetalum humirifolium* and *Ochthocosmus africanus*.

The single-traced petals show contorted aestivation. In *Ixonanthes icosandra*, however, they are imbricate.

The basic number of stamens for the family Linaceae is ten. They are basally united into a tube except in *Ochthocosmus africanus* and *Ixonanthes icosandra* where the staminal filaments are adnate to the disc at the base. The number of stamens is ten in *Roucheria griffithiana*, *Hebepetalum humirifolium* (present study), *Durandea pentagyna* and *Hugonia mystax* (Narayana, 1964); they are of two heights, the antepetalous ones being shorter. In *Linum grandiflorum*, *L. rubrum*, and *Reinwardtia trigyna* the stamens of the antepetalous whorl are represented by non-vascularized filaments, while in *Ochthocosmus africanus* they are completely suppressed and there is no evidence, either external or anatomical, of a missing antepetalous staminal whorl. In *Ixonanthes icosandra*, however, there is an amplification in this staminal whorl.

In *Hebepetalum humirifolium* (present study) and *Hugonia mystax* (Narayana, 1964) the antesepalous and antepetalous staminal traces arise in two distinct whorls in the same order. The androecium in *Durandea pentagyna* (Narayana, 1964) is obdiplostemonous, the antepetalous staminal traces departing earlier than the traces for the antesepalous stamens. In *Roucheria griffithiana* and *Ixonanthes icosandra* all the ten staminal traces arise at one level and this condition may have arisen as a result of suppression of the internode between the two whorls of stamens. In the latter species the antepetalous staminal traces undergo chorisis. The antepetalous stamens in *Linum grandiflorum*, *L. rubrum* and *Reinwardtia trigyna* (Narayana, 1964) are represented by staminodes but their traces are completely suppressed. In *Ochthocosmus africanus* the antepetalous stamens as well as their traces have suffered total reduction.

A glandular, non-vascularized, intrastaminal disc is present in *Ochthocosmus africanus* and *Ixonanthes icosandra*. The adnation of the stamens with the disc



Figs. 37-47. *Ixonanthes icosandra.* Fig. 37. L. S. flower showing the vascular traces to the different floral parts. Fig. 38. Section of the sepal showing the elongated palisade-like cells of the inner epidermis. Figs. 39-47. Serial transverse sections of flower-bud; for explanation see text.

seems to suggest that it may be of staminal origin.

The basically pentamerous gynoecium shows reduction in the number of carpels as in *Roucheria griffithiana* (present study), *Hugonia mystax* (Narayana, 1964). They are 3-traced in *Roucheria griffithiana* and 5-traced in *Hebepetalum*

humirifolium, *Ochthocosmus africanus*, *Ixonanthes icosandra* (present study), *Linum grandiflorum*, *L. rubrum* and *Reinwardtia trigyna* (Narayana, 1964). The common median lateral traces show adnation with the staminal traces in *Hebepetalum humirifolium*, *Ochthocosmus africanus* (present study), *Linum grandiflorum* and *L. rubrum* (Narayana, 1964) or with the common ventral bundles in *Ixonanthes icosandra*. In the light of Puri's concept (1952) the placentation in *Roucheria griffithiana*, *Hebepetalum humirifolium* (present study), *Durandea pentagyna* and *Hugonia mystax* (Narayana, 1964) is axile and parietal in *Ochthocosmus africanus*, *Ixonanthes icosandra* (present study), *Linum grandiflorum*, *L. rubrum* and *Reinwardtia trigyna* (Narayana, 1964). In the possession of a common style *Ochthocosmus africanus* and *Ixonanthes icosandra* differ from the other investigated species of the family.

The Linaceae agree in their floral morphology closely, but *Ochthocosmus africanus* and *Ixonanthes icosandra* differ from the rest in having a gamosepalous calyx, free stamens, a non-vascularized disc and a common style. They are placed under Linaceae by Bentham and Hooker (1862–1893) and Engler and Prantl (1931), but Hutchinson (1959) placed them in a separate family, Ixonanthaceae, under the order Malpighiales. The present study suppots Hutchinson's view in some characters.

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Literature cited

Bentham, G. and Hooker, J. D., 1862–1893 Genera Plantarum. London. Engler, A. and Prantl, K., 1931 Die Naturlichen Pflanzenfamilien. 2 Aufl. Bd. 19a. Berlin. Hutchinson, J., 1959 Families of Flowering Plants. 2 ed. Vol. I. Oxford. Nagaraja Rao, A., 1962 Floral anatomy and gametogenesis in *Hopea racophloea* Dyer. J. Indian Bot. Soc. **41**: 557–562. Narayana, L. L., 1964 A contribution to the floral anatomy and embryology of Linaceae. J. Indian Bot. Soc.

43: 343-357. Puri, V., 1952 Placentation in Angiosperms. Bot. Rev. **18**: 603-651. Saunders, E. R., 1937 Floral Morphology. Vol. I. Cambridge.

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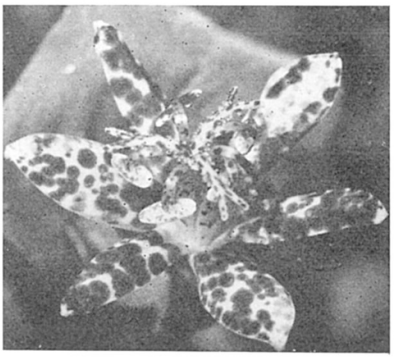
アマ科植物の 4 種類について，花部形態を述べる。

アフリカ産 *Ochthocosmus africanus* とインドネシア産 *Ixonanthes icosandra* とは合がくである。交互ふく瓦状のがく片には 3 本の葉跡が入り，花弁では 1 本である。*Ixonanthes icosandra* では花弁に対生する雄ずいの維管束に分生現象が見られる。中軸胎座がインドネシア産 *Roucheria griffithiana* とブラジル産 *Hebepetalum humirifolium* に見られ，*Ochthocosmus* と *Ixonanthes* では側膜胎産である。

Ochthocosmus と *Ixonanthes* とは花の解剖学的性質が他のアマ科植物とは異っている。従来の成果及び本報告を考え合わせると，Hutchinson がしたように両属を Ixonanthaceae として別科に扱って良いだろう。

○ホトトギスの一形（久内清孝） Kiyotaka HISAUCHI: A form of *Tricyrtis hirta* Hooker



Tricyrtis hirta Hook. f. *atro-purpurea* Hisauchi. × 1.2.

千葉県，船橋市，三山（ミヤマ）といえば，公式行政区域の名であるが，一般には習志野として知られているところの一角に，二宮神社という社があり，その裏山は林地である。ここに写真のようなホトトギスの一形が自生している。花がい片，花糸，柱頭に，黒紫色の斑点が顕著である。これを移植しても，その形質は多年にわたり変らないから，安定していると思われるので，おとなげないが，マダラホトトギスの新称を提唱することにした。紫斑点というのは興林会編，標準色鑑の 20 号に近い色彩である。なお産地は団地化しつつあるから遠からず消失するであろう。

（東邦大学薬学部）

Tricyrtis hirta Hooker forma **atro-purpurea** Hisauchi form. nov.

Perianthium, filamentum et stigma atro-purpureo-maculata.

Hab. Miyama, Funabashi, Chiba pref. (Typus in Herb. Univ. Tokyo.)